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Specialization in Engineering Education

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ACQUAINTANCE with the whole field of human knowledge, with the laws of mind and of matter, with the history of men and of the universe, with esthetics and physics, with theology and chemistry, is beyond the intellectual ability of any one man. Each must restrict his detailed, intensive study to those portions of the general field that are important to him by reason of his individual tastes or of his own duties and responsibilities, although this restriction need not and should not prevent his attainment of such breadth of culture as will give him understanding and sympathy with all men of high ideals and earnest purpose, whatever may be their own special interests.

Our modern civilization, to a greater extent than any earlier social system, makes use of the applied natural sciences. During the past two generations the importance of the engineer has been so thoroughly recognized and the demands for his services have been so many, that the education of young men specifically for engineering work is now of major importance. Much may be said of the desirability of providing such education in graduate schools, but since the greater number of students cannot spend seven or eight years in college, the typical engineering course requires only graduation from High School as preparation and is completed in four years.

Engineering, from the educational standpoint and from the professional standpoint, has come to be a distinctly specialized field of knowledge and of practice. Just as the engineer as such may be considered as a specialist, so also within the engineering profession subdivision has been natural and inevitable. The terms civil engineer, mechanical engineer, electrical engineer and chemical engineer have become accepted in our vocabulary and indicate the intensive development of one or another phase of engineering. Differentiating even further, we have engineers specially qualified by education and experience for railway construction or operation, for textile manufactures, for the rubber industries, for sanitation projects, for aeronautics, for power plant design, for telephone and allied enterprises, for problems involving artificial lighting, or for some one of a rapidly increasing number of other activities.

As typical of the kind of problems involved in the arrangement of a four-year engineering college course intended to constitute preparation for work in a specialized field, a course in fire protection engineering is considered in the present discussion. Adequate discussion of the subject will involve consideration of the question whether there is real need of such a course, and, if there is such need, an inquiry as to what the content of the course should be.

No extended argument is necessary to bring

conviction that the loss by fire in this country is exceedingly large—that it is a serious drain on the nation's resources—and that a large part of the loss is preventable.

The portion of the wealth of the country that is represented by buildings is subject to severe damage in fire, even though some of the building materials are not combustible. Almost all the wealth that is in the form of personal property, as distinguished from buildings, is even more susceptible to damage. The ordinary activities of life; the heating, lighting and power equipment of buildings; and an important proportion of the processes in industrial establishments involve fire hazard inasmuch as they may become active causes of ignition in situations where fuel to permit continued combustion is present. Ordinary care in safeguarding these hazards will do much to prevent fires, but a maximum degree of security can be obtained only when the problems involved in building construction, in the management of occupancy hazards, and in the provision of protective equipment have received adequate consideration by men whose special knowledge and training have given them special ability in this particular field. The fire insurance companies and the numerous organizations associated with them in the reduction of fire waste and in the related problem of the measurement of fire hazard for the purpose of establishing fire insurance rates, have recognized this fact by employing large numbers of graduates of engineering schools, especially mechanical and chemical engineers, and by assigning these men to such duty as will as rapidly as possible add specialized training in the problems of fire protection to the fundamental engineering knowledge that they have already acquired. These men have done notable work, and to a greater extent each year the more responsible positions in the fire insurance field have been assigned to them. It is not a reflection upon their achievements to say that their development of special ability in fire protection would have been even more rapid if their college work had been planned with this end in view. The situation is, therefore, this—there is a field of great importance in which the fire protection engineer can work; there is a general recognition of this fact in the fire insurance business and in the community; and specific training in fire protection during a college course will give special possibilities for rapid advancement in such work after graduation.

In considering the arrangement of a college course in fire protection engineering, we meet at the beginning something of a paradox in the fact that excessive specialization must be avoided. The conditions and the materials that influence fire hazard are so varied that it appears as though there is no kind of engineering knowledge and

experience that is not likely to be of value to a fire protection engineer at one time or another. It follows that the mathematics, physics, mechanics and chemistry that form the foundation of any sound engineering course are especially important in this field. Further, training in chemistry is needed in the investigation of the phenomena of ignition and combustion, and in the treatment of the numerous hazards of occupancy. A sound knowledge of hydraulics is essential for obvious reasons. The study of electricity is important because of the fire hazard of electrical installations and because of the common use of motors for driving fire pumps and other extinguishing apparatus.

The design and construction of buildings and the properties of building materials must have adequate discussion. The importance of broad training in those subjects that are not peculiar to fire protection is indicated by the fact that a fair number of the students who have been registered in the Department of Fire Protection Engineering at Armour Institute of Technology have elected that course on account of their desire to obtain a general engineering education.

In the department referred to, the purely professional subjects begin in the second year and occupy a gradually increasing portion of the student's time until in the latter part of the fourth year he is concerned almost entirely with subjects relating to fire protection and fire insurance. He is given special courses in the properties of fire retardant devices and materials, in protective equipment, both private and public, in the rules and standards of the National Board of Fire Underwriters and of Underwriters' Laboratories. For two years he spends six hours each week in conducting experimental work at the Laboratories. In his last half year he spends one day each week in field inspections. Throughout one year he attends lectures on fire insurance practice, involving discussion of policies, forms, clauses, the mathematics of insurance accounting, insurance law, company and bureau organization, and underwriting rules and methods. Particularly careful and detailed instruction is given in the principles and the application of the "Analytical System for the Measurement of Relative Fire Hazard" in one course in the second year, and a more comprehensive course in the fourth year, the latter being closely related to the field inspections of special hazards.

Recognition of the value of the work of the department, and invaluable assistance in its development have come from fire insurance organizations. For twenty-one years the students have had the use of the elaborate equipment of Underwriters' Laboratories. In yet another form the fire insurance companies have co-operated with the department, by the establishment of scholarships. In 1913, the Underwriters' Association of the Northwest, on the initiative of its president, Mr. Wellington R. Townley, inaugurated a plan whereby one four-year scholarship was awarded each year. In 1920, the principle of the scholarship plan having been shown to be sound, Mr. Jackson V. Parker, Manager of the Western Ac-

tuarial Bureau, proposed to Armour Institute of Technology that a new and elaborate system of scholarships be put in operation, and a detailed plan for the system was agreed upon with the officers of the school. In most respects it appears that the scholarship agreement is a unique example of co-operation between business organizations and an educational institution and it represents an appreciation of the facts that from the standpoint of sound finance it is proper to invest a large amount of money in the training of selected men, and that the selection should be made while the prospective students are still in High School or within two or three months after the completion of their High School courses. The plan provides for the awarding of approximately twenty-five scholarships each year, each scholarship being for the full four-year course. Thus far about one hundred awards have been made, and normally there will be about this number of scholarships in effect at all times, the entrants each year replacing those who have graduated. Awards are made by a committee of which the chairman is the Manager of the Western Actuarial Bureau, and the other members are the President of Underwriters' Laboratories, the Secretary of The Union, the Secretary of the Western Insurance Bureau, and the Chairman of the Scholarship Committee of the Underwriters' Association of the Northwest. All students admitted must of course have qualifications defined by the standard entrance requirements of Armour Institute of Technology. Candidates must submit to careful scrutiny by the Scholarship Committee and are judged on the basis of appearance, personality and general desirability as recruits for the business of fire insurance. The geographical distribution is such that men are chosen from nineteen states in the middle west. Each scholarship provides for the payment of tuition and fees at the Institute, for work with an inspection bureau during two months of each of the three summer vacations, and for employment by a bureau for three years after graduation. It has been demonstrated that the employment of the students during the summer vacations in work directly preparatory for their assignments after graduation has been of notable value to them and has made them immediately available for responsible assignments on the completion of the course.

Complete discussion of fire protection engineering, and of the preparation of young men for work in this field, would call for rather extended consideration of the importance of the humanitarian aspects of the problem. Even more important than the preservation of property, which is the phase that has been considered in this paper, is the prevention of physical suffering and of death in fires, which make up each year a shocking history of disaster.

Specialization in the training of engineers has become definitely established as one part of our American system of education. It is to be hoped that this partial description of the working out of the problem in one school may be of interest to those who have similar problems in other schools, involving specialization in other directions.